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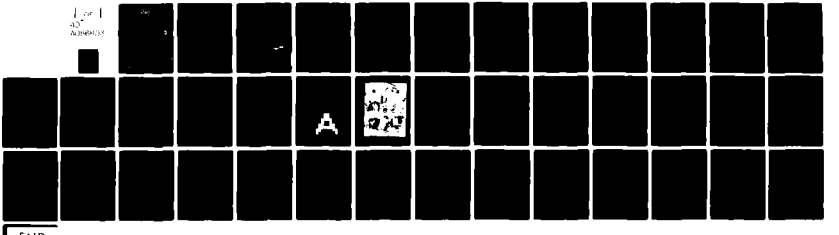

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18 July 1979

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This paper looks at three terminals, teletypewriter, optical character reader, and facsimile, used to input and output record communications on an electronic transmission medium. It examines the advantages and disadvantages of each in satisfying user requirements and asserts that facsimile, with its flexibility, ease of operation, and user convenience, will emerge as the terminal of the future.

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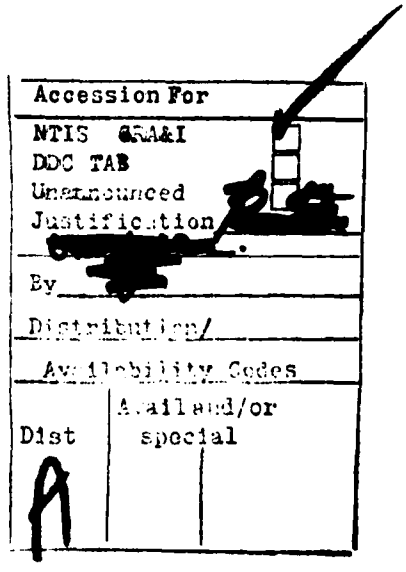
SYNOPSIS

This paper looks at three terminals, teletypewriter, optical character reader, and facsimile, used to input and output record communications on an electronic transmission medium. It examines the advantages and disadvantages of each in satisfying user requirements and asserts that facsimile, with its flexibility, ease of operation, and user convenience, will emerge as the terminal of the future. Phases of facsimile advancement are outlined: (1) facsimile on AUTODIN; (2) a hybrid of facsimile and optical character reading capabilities; and (3) facsimile as an integral part of the "office of the future." Also explored are hardware and software developments currently underway which will eventually enhance facsimile operations.



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INTRODUCTION

In 1970 the Mollohan Committee was established by the House of Representatives Armed Services Committee to investigate Department of Defense (DOD) communications worldwide. Its creation was a direct result of two incidents which seriously questioned the effectiveness of command and control within the DOD: the Israeli attack on the U.S.S. Liberty, 7 June 1967, and the North Korean seizure of the U.S.S. Pueblo, 23 January 1968. In both of these acts of aggression, the lack of defensive action on our part was traced directly to an unresponsive communications network. Four messages, ordering withdrawal from the coast of Israel, were sent to the U.S.S. Liberty between 13 and 3 1/2 hours prior to the attack. None reached the ship in time. Result: 34 men killed, 75 men wounded, the Liberty damaged beyond repair. In the case of the U.S.S. Pueblo, two messages advising National Military Command Authorities of the ship's vulnerable situation, required 2 1/2 and 1 1/2 hours for delivery: too late for U.S. Forces to come to the aid of the ship. Result: one man killed, the remainder of the crew in long imprisonment, the ship lost, classified information compromised. (11:6,11) These results were a costly lesson on the importance of communications. We learned from them.

The following excerpts are from the findings of the Mollohan Committee:

> "Despite those almost perfect communications conditions, messages were lost, misrouted, and missent, while others experienced intolerable delays for in-station processing."

> "The time required for processing messages, before and after their electronic transmission, has prevented any significant improvement in 'writer-to-reader' time, despite installation of automatic switching equipment..."
>
> "The overall effect was that parties who had a need to know -- in one instance the commanding officer of a ship, in the other, National Command Authorities -- were deprived of that knowledge because of a lack of responsiveness on the part of DOD communications systems."

During hearings conducted by the Mollohan Committee, the processes most often identified as having caused delays were excessive message preparation time and human error. (11:3,15,16)

In 1972, the Air Force Communications Service conducted a study of 67 bases worldwide to determine how well communications systems were satisfying user requirements. A major complaint of all users was the slowness and unresponsiveness of the on-base distribution system and electrical message service -- getting messages to and from the Telecommunications Center (TCC) and processing within the TCC. (9:34)

Thus, message preparation time, in-station handling time, and human error have been identified as major obstacles to be overcome in providing fast, reliable, efficient communications service to DOD users. What can be done to reduce or eliminate these problems encountered in getting messages from the writer to the reader?

This paper will investigate the proposal that facsimile can provide the most direct, error-free route from writer-to-reader. It is maintained that facsimile, enhanced by OCR capabilities and transmitted over AUTODIN, can satisfy all record communications requirements of the future.

To understand how facsimile can achieve this objective, it is necessary to look at communications terminals currently in use. The oldest and most common of which is the teletypewriter -- from torn tape relays to minicomputers. The introduction of optical character readers automated many previously manual processes and increased the speed of service. Using facsimile to transmit record communications eliminates or reduces many of the disadvantages of teletypewriters and optical character readers. However, as currently operated, facsimile has several unfavorable features which prevent optimal utilization. As technological advances permit, facsimile transmission can be converted to AUTODIN and integrated with optical character reading capabilities. Data compression techniques, improvements in data coding, hardware advances, and reductions in cost will eventually bring facsimile communications into the office of the user. Before proceeding, however, a few definitions will insure a common basis for discussion.

WHAT DOES A RECORD COMMUNICATIONS SYSTEM CONSIST OF?

The main component of record communications is the record itself. Within this paper, record and message are synonymous, i.e., a hard copy containing information or data pertaining to a particular subject. It can take the form of a letter, formatted document, photograph, handwritten note, graph, or chart. Information contained thereon could be personnel or supply requisitions, battle plans, equipment status reports, orders, administrative data or any other information

which contributes to the command and control of forces. Effective command and control is achieved only when this data is at the right place at the right time to facilitate sound decisions and proper actions.

The interval required to get this information from the originator to the parties who have a need to know is referred to as writer-to-reader time or speed of service. A large portion of writer-to-reader time is consumed by in-station processing which includes the numerous manual processes necessary before transmittal. Some of these processes are message preparation, transit to the Telecommunications Center (TCC), and transition or rekeyboarding into AUTODIN-acceptable format. Some of these require specially-trained personnel; all of them provide opportunities for delay and human error. Only a small portion of writer-to-reader time is consumed by the transmission media (electrical path).

The electrical path used to transfer information from source to destination is fast--with speeds up to 9600 bits of information transferred per second--and AUTODIN II implementation will make it even faster--with speeds up to 50,000 bits per second. This speed, combined with AUTODIN's capability for detection and correction of system-generated errors, eliminates the transmission path as a topic within this paper--it is not an obstacle to fast, reliable communications. Improvements can be realized, however, in the equipment and processes which get messages into and out of the electrical path.

WHAT HAVE WE GOT TODAY?

Today, the U.S. mail transports the bulk of record communications, but with its rising cost and relative slowness (mail delivery is 85% physical labor oriented), it is losing popularity in favor of telecommunications systems. (7) In DOD systems, there are three ways to get messages into and out of the electrical medium: teletypewriter, optical character reader, and facsimile.

TELETYPEWRITER (TTY). TTY was an improvement over costly courier or mail service with their long delivery times and provided a transition into the age of electronic communications with transmission in seconds. But, keyboarding (poking) all messages, inflexibility of operation, and potential for errors, make TTY ineffective in today's fast-paced, ever-changing environment.

TTY Operation. The TTY looks and performs similarly to a common office typewriter. When a key is depressed, a character is printed. At the same time, however, the character is converted to a binary code which is electronically transmitted. At the receiving terminal, the code is translated back to the original character which is printed. Some TTY's have an additional step whereby the output is produced on a paper tape which is then fed into a communications terminal for transmission. Operating speeds range from 50 to 3600 bits per second. Output can be to punched cards, magnetic tape, printer, stored on a disk, fed directly into AUTODIN, or to a computer for query/response or interactive mode of operation.

TTY Coding. Characters are represented by ASCII (American Standard Code for Information Interchange) which requires seven bits of information to represent each character or Baudot which requires five bits per character, plus one bit for a parity check (error detection). Use of these codes affords compatibility between terminals and is an efficient use of telecommunications resources. But, since ASCII is limited to 128 recognizable characters and Baudot to 64, this severely restricts the type of input the equipment can handle.

TTY Procedures. The originator's handwritten or typed draft message is forwarded to the local TCC, i.e., it is picked up at his office, carried to the main distribution center where it is sorted and routed to the TCC. Pick up and delivery are usually on a scheduled basis which means lengthy delays may be encountered all along the route. Actual message preparation time is dependent on the availability/expertise of the operator who keyboards the message on special paper in a prescribed format. Proofreading and correction of errors can be time-consuming and, if not adequately done, can result in rejected messages, retransmittals, and bad information being received at the destination. The operator looks up the AUTODIN Routing Indicator (address of the intended recipient) for all addressees on the message. Any discrepancies/confusion in the message is referred to the originator for resolution. Any deviation from standards will result in the message being rejected by the AUTODIN system. Received messages are reproduced within the TCC, a copy filed, and distribution made. Distribution means that the appropriate number of copies are placed in

each activity's hold box or folder where they await pick-up by a courier from that activity or the on-base distribution center who eventually gets the message to the office of the addressee.

A summary of teletypewriter operational characteristics is presented in Table 1. It may be noted that these characteristics, when later compared to those of the optical character reader and facsimile operation, are not favorably balanced.

TABLE 1

ADVANTAGES/DISADVANTAGES OF TELETYPEWRITER OPERATIONAL CHARACTERISTICS

ADVANTAGES	DISADVANTAGES
One input can be addressed to many recipients	Requires a trained operator
Multi-media output	Rekeyboarding original document provides opportunities for errors
Minimum communications costs	Input must be redone in prescribed format (time-consuming)
Uses ASCII or Baudot codes	Large number of people involved in manual processes
Output easily encrypted	Inconvenience (getting message to and from the TCC, hours of operation, formalities)
Uses AUTODIN	Requires special supplies (paper, keyboard, printer)
	Handles only one type of input (no photographs, handwriting, or graphics)
	Some models require preparation of paper tape
	Limited character recognition (ASCII - 128 characters; Baudot - 64 characters)
	AUTODIN will reject any deviation from standards

OPTICAL CHARACTER READER (OCR). The use of OCR equipment enables reductions in TCC manpower resources while speeding up narrative message preparation/handling processes. Also, the equipment automatically checks for certain types of errors.

OCR Operation. An optical scanner, using a very high intensity light, looks at one character at a time. Light and dark spots are analyzed and a corresponding series of electrical pulses produced. This series of pulses is compared to patterns stored in memory. If a match is found, the binary code representing that particular character is transmitted. If the character cannot be recognized, processing stops and the page is projected on a Visual Display Unit (VDU) for operator intervention. Simple corrections can be made at the VDU, but more difficult ones must be referred back to the originator. The equipment automatically does paging and sectioning of the message, validates classification and precedence information, provides a log of all messages sent, and assigns the station serial number, date, and time. Routing Indicators are stored in memory and automatically assigned based on the Plain Language Address (PLA) contained in the message. Address Indicator Groups (AIG's) may be used to simplify message preparation, i.e., a four-digit AIG will cause the OCR to send the message to up to fifty addressees. When no errors are encountered and no operator intervention required, 250 pages can be processed per hour. Output media is the same as for the TTY. At the receive terminal, the code is converted back to the original character which is then printed and the message is reproduced, filed, and distributed the same as a TTY message.

OCR Coding. Characters are represented by ASCII, limiting the OCR to 128 recognizable characters. Messages are prepared on special typewriters, with a particular font, in a prescribed format.

OCR Procedures. A typist in the originator's office prepares DD Form 173 (Figure 1) from the originator's draft. This takes the message preparation function out of the TCC but does not eliminate it. DD Form 173 is a special purpose form used to prepare messages which are to be processed by OCR equipment. Incoming and outgoing messages follow the same route to and from the TCC as TTY messages. They also encounter the same handling delays except that OCR messages are processed more quickly within the TCC since they do not require rekeyboarding there. Any deviation from prescribed preparation instructions will cause the message to be rejected by the OCR equipment. This includes smears, smudges, and distorted characters (the OCR reads, but cannot recognize these "characters"). Error correction is simplified by use of the VDU; however, a full-time trained operator is still required.

A summary of OCR operational characteristics is presented in Table 2. It may be noted that OCR is an improvement over TTY but still contains limitations in satisfying user requirements.

JOINT MESSAGEFORM

SECURITY CLASSIFICATION

PAGE OF	DRAFTER OR RreleaseR TIME	PRECEDENCE AST	PRECEDENCE INFO	LMF	CLASS	CIC	FOR MESSAGE CENTER/COMMUNICATIONS ONLY	DATE-TIME	MONTH	YR

BOOK | MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

6
5
4
3
2
1
0

DISTR:

0

DRAFTER TYPED NAME, TITLE, OFFICE SYMBOL, PHONE & DATE	SPECIAL INSTRUCTIONS	
RELEASER: TYPED NAME, TITLE, OFFICE SYMBOL AND PHONE		
SIGNATURE	SECURITY CLASSIFICATION	DATE TIME GROUP

DD FORM 1 DEC 70 173 (OCR) REPLACES DD FORM 173, 1 JUL 68, WHICH WILL BE USED.

FIGURE 1

TABLE 2

ADVANTAGES/DISADVANTAGES OF
OPTICAL CHARACTER READER OPERATIONAL CHARACTERISTICS

ADVANTAGES	DISADVANTAGES
One input can be addressed to many recipients	Extremely sensitive to deviations from standards
Multi-media output	Requires a trained operator
Minimum communications costs	Original document must be retyped on special form, in special format, with special typewriter (time-consuming)
Uses ASCII code	Large number of people involved in manual processes
No paper tape required	Retyping may introduce transpositions, typographical errors
Output easily encrypted	Inconvenience (getting message to and from the TCC, hours of operation, formalities)
Uses AUTODIN	Requires special supplies
Automatic address look-up	Handles only one type of input (no photographs, handwriting, or graphics)
Automatic insertion of station serial number, date and time	Limited character recognition (128 characters)
Validates classification and precedence of message	AUTODIN will reject any deviation from standards

FACSIMILE (FAX). FAX is the easiest, fastest way for two people to communicate or coordinate via record communications. It eliminates the "middlemen" and formalities of TTY and OCR transmissions and provides the most direct route between writer and reader.

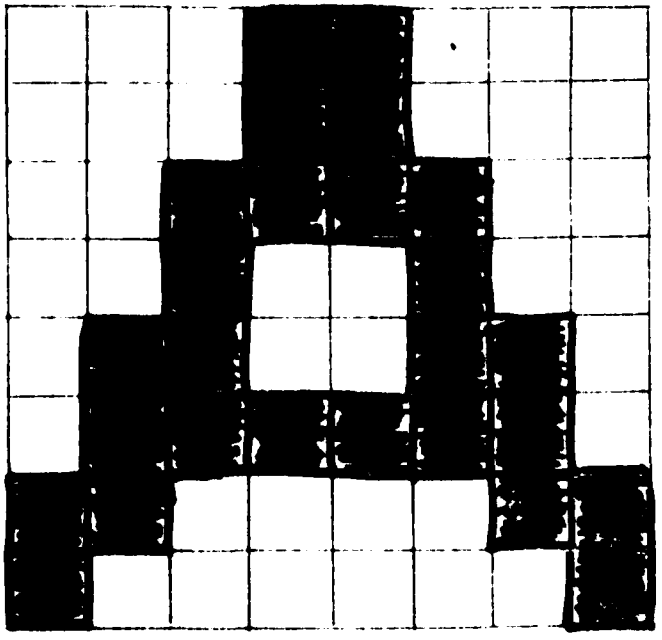
FAX Operation. Like OCR, FAX uses an optical scanner, but instead of looking at and coding a character at a time, the scanner looks at a spot (1/10,000 of an inch in diameter) at a time, determines the presence or absence of a mark (blackened/unblackened place), and transmits this information. At the receive terminal, this information is reconverted to marks or no marks on a sheet of paper to reconstruct the original document. (1) Transmission is via AUTOVON using an acoustic coupler. FAX can also act as an office copier and night transmissions take advantage of lower telephone rates and idle circuits.

FAX Coding. Analog transmission is in two states: mark or no mark. A reconstructed "A" is shown in Figure 2 on an eight-by-eight matrix. Actual operation is more detailed and accurate than this. In digital FAX, the presence or absence of a mark is transmitted using binary codes which allow for the representation of different shades of gray, along with the other benefits derived from digital transmission. An unlimited number of characters, symbols, and patterns can be reproduced, permitting transmission of photographs, graphics, signatures, and handwritten documents. The price for this capability is that, on the average, one character requires 400 bits of information (compared to 8 bits for OCR) to insure quality resolution at the receive terminal. Figure 5 is a sample of the quality of facsimile available today.

FIGURE 2
FACSIMILE CODING

0	0	0	1	1	0	0	0
0	0	0	1	1	0	0	0
0	0	1	1	1	1	0	0
0	0	1	0	0	1	0	0
0	1	1	0	0	1	1	0
0	1	1	1	1	1	1	0
1	1	0	0	0	0	1	1
1	0	0	0	0	0	0	1

Binary Information Transmitted
(1 represents a mark 0 represents no mark)



Letter "A" Reconstructed

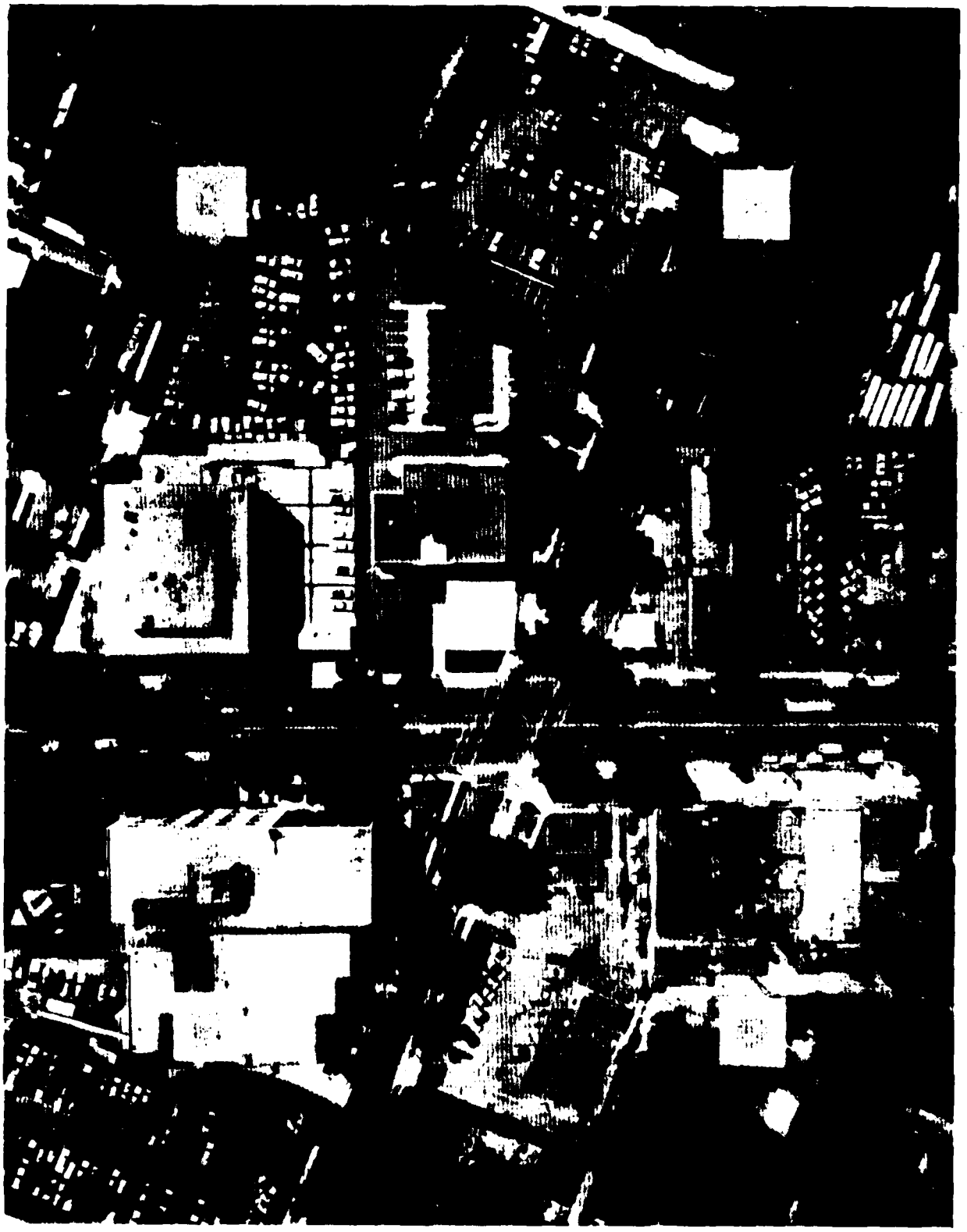


FIGURE 3
Facsimile Sample

FAX Procedures. Most FAX devices are located in the user's office (some are in TCC's). The original document is inserted (no retyping, special forms, or formats), verbal coordination is established with the receiving terminal, the telephone is placed in an acoustic coupler, and transmission begins. FAX stops automatically at the end of the page, and the operator inserts the next page. At the end of transmission, verbal coordination with the receiving terminal insures that all pages have been received and the quality is good.

A summary of facsimile operational characteristics is presented in Table 3. It may be noted that these characteristics, when compared to TTY and OCR operations, are heavily on the side of advantages.

TABLE 3

ADVANTAGES/DISADVANTAGES OF FACSIMILE OPERATIONAL CHARACTERISTICS

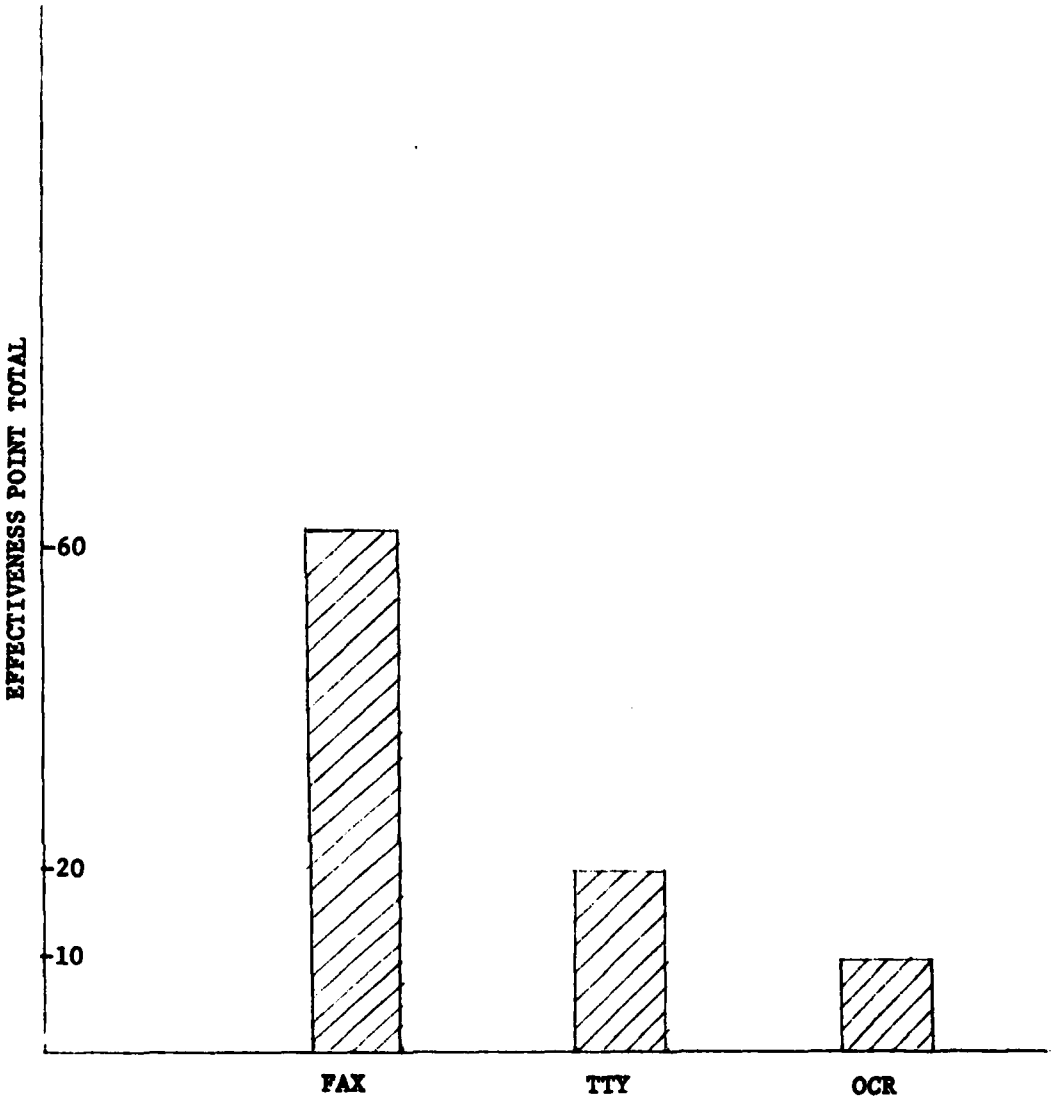
ADVANTAGES	DISADVANTAGES
Most direct route between writer and reader	Single addresses only
No chance for transposition or typographical errors	Unsecure
Analog FAX is cheap	Requires many bits of information to be transmitted (high communications costs and inefficient use of codes)
The human eye is the final detector, therefore, minor deviations are acceptable	Ties up AUTOVON lines
Does not require a trained operator; easy to operate	No industry or Government standards
Accepts original documents; no retyping or poking	
Minimal number of "middlemen" means less chance for errors	
No special forms, formats, supplies, or typewriters	

TABLE 3 (Continued)
ADVANTAGES/DISADVANTAGES OF FACSIMILE OPERATIONAL CHARACTERISTICS

ADVANTAGES	DISADVANTAGES
Can handle any type of input (photographs, handwriting, graphics, etc.)	
Nominal restrictions which could reject a message from the system	
Unlimited character recognition	
No paper tape	
Convenience (located in the user's office)	
Easily installed (transportable)	
Not susceptible to errors generated within the distribution system or handling within the TCC	
Can transmit signatures	
Can aid in reducing TCC manpower requirements	
Digital FAX can be secured	
Can replace TTY and OCR capabilities with a single piece of equipment	

ANALYSIS OF EQUIPMENT. A study completed by the U.S. Army Signal School concluded that FAX can reduce writer-to-reader time by a factor of three and communications personnel requirements by a factor of ten when compared to TTY use. (6:38,45) The effectiveness of FAX, compared to TTY and OCR is graphically shown at Figure 4, where the advantages and disadvantages of each equipment are summarized.

FIGURE 4



COMPARISONS OF EFFECTIVENESS IN
FULFILLING VARIOUS APPLICATIONS (2: 5-3)

Effectiveness is defined as: (1) ability to satisfy user requirements; (2) flexibility; (3) susceptibility to errors; and (4) convenience. (2:5-3) By reducing the number of procedures and people involved, FAX virtually eliminates the delays and human errors experienced in today's systems. Its ability to accept any form of input does away with the need for special purpose input devices and provides all the services needed to satisfy user requirements.

Also, FAX is less susceptible to system-created errors. A few bit errors will not alter the meaning of the message. However, the same number and type of errors could completely change the meaning of a TTY or OCR message. (2:2-10) The advantages to be derived from FAX use make it a prime candidate for intensive research and development.

So, if FAX offers so many benefits, why isn't everyone using it? Analog FAX devices have been procured from many different manufacturers throughout the years--they are often incompatible (7), require different maintenance contracts, and are not conducive to centralized management which usually results in monetary savings. (5) But efforts are underway to regulate the procurement and use of FAX. Army and Air Force have recognized FAX as communications equipment (Navy still considers it office equipment) and have placed FAX under the control of their communications agencies. Establishment of these single authorities should bring about standardization, interoperability, compatibility, and the visibility FAX needs for its future expansion.

The main factor preventing universal acceptance of FAX is its high communications costs as indicated in Table 4 and shown graphically in Figure 5. One reason for the high cost is the amount of information required for transmission to reproduce the original document at the receiving terminal. To transmit a 250 word page requires the following bits of information:

TTY with ASCII	12,000 bits
OCR with ASCII	12,000 bits
Digital FAX with data compression	190,000 bits
Analog FAX without data compression	900,000 bits

(4)

These high bit rates for FAX require greater equipment capacity and complexity within the transmission media.

Another reason why FAX communications costs are so high, and the main reason for its disadvantages as listed in Table 3, is the current practice of transmitting FAX on AUTOVON. AUTOVON was designed and operates as a voice communications network and transmitting data over it is an inefficient use of facilities. One voice grade channel can be broken down into 16 data circuits, yet FAX uses the entire voice channel and costs are incurred accordingly. AUTOVON is unsecure and there are very few controls at present to prevent transmission of classified traffic. When FAX and other data traffic saturate AUTOVON, voice communications requirements are not satisfied. (5)

Getting FAX traffic off AUTOVON and reducing the amount of bits required for transmission would greatly enhance the desirability of FAX. As a matter of fact, these problems are being worked on right now and, hopefully, will soon be resolved.

TABLE 4. COST COMPARISONS

ITEM	FAX	TTY	OCR
a. Data Preparation[1]	$2.4K/yr[2]	$3.6K/yr	$3.2K/yr
b. Purchase Cost	$10K[3]	$2K	$10K
c. Maintenance & Operation	$1.5K/yr	$1.2K/yr	$1.1K/yr
d. Communications[4]	$24K/yr	$1.2K/yr	$0.6K/yr
e. Life-Cycle Cost[5,6] With Communications	$289K	$62K	$60K
f. Life-Cycle Cost[5,7] Without Communications	$49K	$50K	$54K

[1]Based on best guess of usage per day and amount of personnel/skill involved.

[2]FAX preparation cost would be nil in cases where the document is being prepared for another purpose.

[3]Includes data compression.

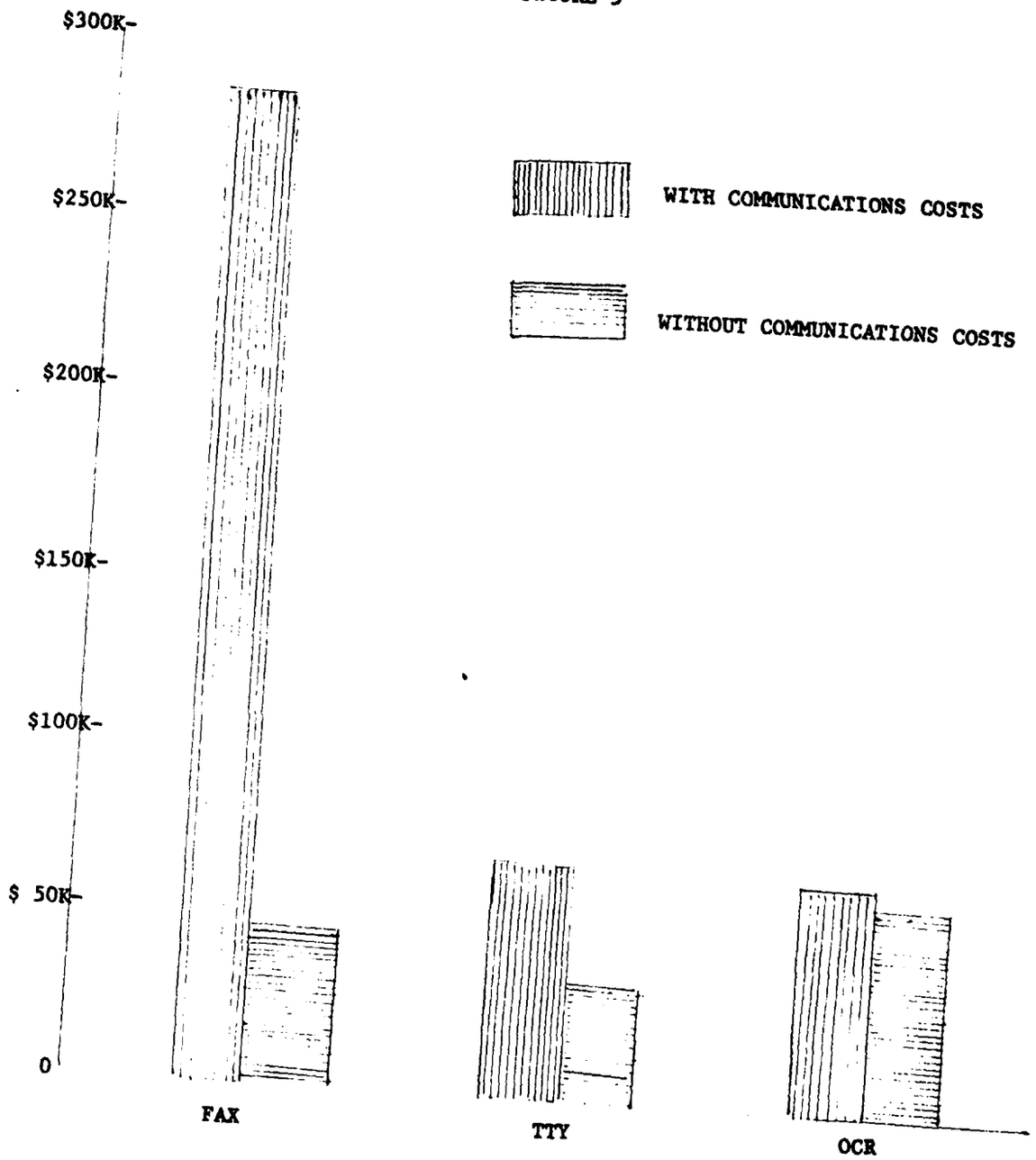
[4]Based on 4800 Baud; 6 hour/day usage; 1 Kilomile link.

[5]Based on a 10-year life.

[6]e = (a + c + d)10 + b.

[7]f = (a + c)10 + b. (2: 5-4)

FIGURE 5



LIFE-CYCLE COST COMPARISONS (2:5-5)

WHERE ARE WE GOING?

"If the Pony Express and Samuel Morse were the communications pioneers of the past, then facsimile is without question the pioneer of the future."

Raymond Herzog
Chairman and Chief Executive Officer, 3M Company

Just as telephones have become an indispensable tool for all business activities, modern technology will soon permit a facsimile terminal to occupy space on a desk to provide convenient, efficient transfer of written information. The following actions, when successfully implemented, will bring this concept into reality.

FACSIMILE OVER AUTODIN. In June 1978, the U.S. Army Communications Command set up a testbed of four high speed, digital, secure facsimile terminals operating over AUTODIN. Terminals consist of the DACOM 412 FAX transceiver, an AUTODIN interface device, and a Teletype Corp. Model 40 teletypewriter. (5) As a result of this project, technical difficulties are being resolved, protocols and procedures refined, and future requirements established. Preliminary reports indicate that customers are not using this service because they find it more convenient to use the dedicated FAX located in their office. They do not want to be bothered with filling out the required forms, carrying their message to the local TCC, then verifying its receipt. They are more concerned with convenience than with the cost and inefficiency associated with operating FAX over AUTOVON. The conclusion here is that FAX cannot be taken off AUTOVON until the user can be offered something better in its place. Analog FAX devices

have been transmitting over AUTOVON for a long time. They are cheap ($8,000) compared to digital FAX for AUTODIN use ($48,000). Therefore, getting FAX traffic off AUTOVON is not going to be an easy task. (5)

Another problem to be resolved is system credibility. As with any new system, operators don't trust it (often this distrust is simply a lack of knowledge of its operation). They do not use its full capabilities and cling to the old way of doing things. But, progress is being made and problems are being resolved.

A Statement of Work (SOW) has been prepared for the procurement of an Army-standard FAX which will operate over AUTODIN. Specifications include compatibility with DCA criteria (draft Military Standard (MIL STD) 188-161), NATO, and TRI-TAC equipment. The procurement package should be ready for contractor bids by March 1980. FAX on AUTODIN will meet DOD objectives to secure all traffic and aid in current policy to consolidate TCC's wherever possible, to reduce operating hours and personnel requirements. (5)

The goal is to eliminate FAX traffics from AUTOVON. While this is being accomplished, the next step, enhancing FAX capabilities, is also being investigated.

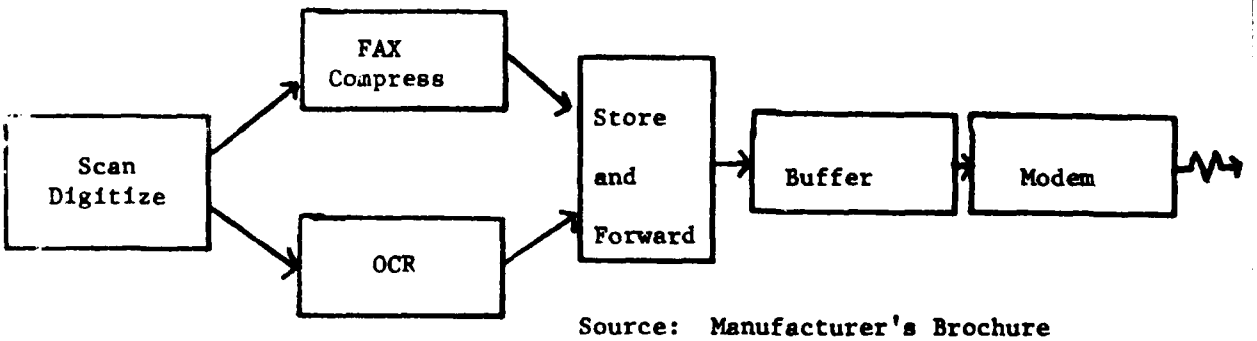
INTERCHANGE OF FACSIMILE AND OPTICAL CHARACTER READER. The Air Force Communications Service is taking the lead in procuring equipment capable of interchange between OCR and FAX capabilities. Earlier this year, a Synopsis for Source List was run in the Commerce Business Daily for Combined OCR/TELEFAX Equipment to which the following vendors responded:

Datalog Division, Litton Systems
SMS Data Products Group
Lundy Electronics and Systems, Inc.
DBA Systems, Inc.
Compuscan
Graphic Sciences, Inc.
Dest Data Corp.
Stewart-Warner Corp.

(4)

Of these, two are actively working at developing this concept.

Dest Data Corp. has applied for patents on a single unit which is OCR or FAX selectable:



Source: Manufacturer's Brochure

Stewart-Warner Corp. is developing this concept in phases and plans to add FAX to their OCR in 1981. Another added feature they have come up with is combining the scanner and microcomputer into a single unit. (12:28)

The interchange of FAX and OCR will result in elimination of redundant equipment within a TCC. Currently, OCR and FAX are completely separate entities. According to this concept, they will share a common scanner, central processing unit, and buffer and most likely at least one operator's space can be saved within the TCC. The next phase of development will bring about even more savings.

HYBRID FAX/OCR. ~ :hnology continues at its current rate, by 1985 a single piece of equipment which uses an optical scanner and automatically switches from OCR to FAX while reading a single page can be in use. Characters which are recognized by the OCR will be converted to an ASCII code with its economy of transmission bits. If a character cannot be recognized, operation will switch to FAX to record that character or symbol, then back to OCR. This eliminates the need for operator insertion of unidentifiable characters. Also, capabilities are further consolidated into one piece of equipment, eliminating redundant units.

These plans are contingent on the rate of developments now taking place in hardware and software engineering. And there is much activity in these areas.

HARDWARE AND SOFTWARE DEVELOPMENTS. These two areas are so interrelated, it's impossible to discuss one without impacting the other. Improvements in one lead to improvements in the other, so too with problems.

Hardware. Large scale integrated circuit (LSI) improvements will make equipment smaller and cheaper, increase capabilities and capacity, and reduce processing time. Modular printed circuit boards and PROM's (programmable read only memory) will provide system flexibility and simplification. Laser scanning and recording will improve optical scanning techniques.

Equipment compatibility and standardization will extend the community of interest and reduce software development costs. The

International Telegraph and Telephone Consultative Committee (CCITT) has established standards for FAX transmission which include standardization of apparatus and procedures. (12:A-1) When published, draft MIL STD 188-161 will standardize FAX specifications within DOD.

Advances in color reproduction capabilities of office copiers and cathode ray tubes (CRT's) may spill over into the FAX environment since they operate on the same principles. Weather and tactical applications, where the value of FAX is already recognized, are bringing more attention to the FAX industry. Improvements in these areas will foster the use of FAX for record communications requirements. The U. S. Postal Service is doing research into electronic mail (FAX) and a limited system tying together ten post offices is planned for 1981. (2:6-30)

AUTODIN II promises one-tenth of a second transmission time from initial to destination node with 50 kilobit per second digital facilities. Packet switching allows this high bit rate without saturating the system. Use of satellite and fiber optic transmission links also will allow more throughput at greater speeds. Roof-top antennas can provide convenience.

The use of digital transmission media by the AT&T network is increasing and should bring about reductions in data transmission costs while promoting digital communication use. The digital levels of carriers are:

T1 carrier:	1.5 megabits/second	(operational)
T2 carrier:	6.3 megabits/second	(operational)
T3 carrier:	45.0 megabits/second	(under development)
T4 carrier:	224.0 megabits/second	(under development)

(2:4-43)

Software. FAX related software developments are mainly in providing coding schemes which will reduce the number of bits transmitted to reproduce the original document. Following are some areas being investigated.

Data compression can take several forms but its main purpose is to remove all unnecessary information prior to transmission of the codes. This can be done by "coding the codes" such as sending an 8-bit code to represent a particular arrangement of ones and zeros. Digital processing allows for this coding and high compression ratios can be achieved (on the order of 50:1). For example, instead of sending a row of ones to indicate that a line on a page has no marks on it, send a code which conveys this information. An example of data compression is sending the letters "MS" to represent the word "Mississippi." Also, the transmitter can continually scan the remainder of the page, when no more information is there, a code can be sent ending transmission. Other names for this process are "run length coding" and "redundancy reduction." (1)

Researchers are constantly looking for new algorithms for coding which will allow maximum transfer of information with minimum bit transfer rates. This is evidenced by the wealth of reports and studies available on this subject. Algorithms are a way of determining how the information will be coded for transmission.

Combined Symbol Matching, which combines OCR and FAX features, was developed by Compression Labs of Campbell, California. When a character is first encountered on a page, it is given a code. Subsequent characters are read, compared with those already coded and

if a match cannot be found, a new code is assigned. Unlike OCR, this system can read any type of typewriter font. (1) This capability is operational today.

Research being done in pattern and symbol recognition consists of looking at the features of the input: fragments of strokes (curved, vertical, or horizontal lines) which make up the alphanumerics, pictures, or graphics a document might contain. A library is formed in memory of all possibilities, then, when a document is scanned, its minute characteristics are compared to those in memory and, when a match is found, coded for transmission. This is an enormous undertaking but most sources feel it is achievable.

All this technology will combine and interact to produce a fast, efficient method of transmitting record communications. A concept of its operation will now be presented.

HOW WILL IT OPERATE?

Just as remote terminals have brought computer power directly into the user's office and telephones have given him worldwide voice communication, soon, FAX terminals will give users the most direct, fastest route between writer and reader for record communications. This ability will be provided over low-cost, secure data circuits.

This FAX network will be similar in operation to today's telephone system. Compact, easy to operate scanners will be located at the user's desk; for small volume users, they can be centrally located. A central

switching center will perform processing functions such as a dial central office performs for telephone calls. Automation will mean minimal human intervention and errors. Personnel requirements, message preparation time and manual processes will be reduced or eliminated.

Procurement and maintenance contracts will be centrally managed to insure cost savings and compatibility. The need for special purpose equipment such as teletypewriters, optical character readers, and office copiers will be eliminated--FAX can do it all.

This concept is not new. It is touched upon in any discussion of the "office of the future" where automation is the key to streamlined operations.

Operation of the send terminal will not require a trained operator. All pages of the document will be loaded into the input stacker, the operator will select the degree of resolution required and paper length, insert address of destination, and press the "SEND" button. No retyping, special formats, or input restrictions. Input is scanned, information digitized, and electric pulses sent to the central switching center. A log is automatically kept of all sent messages. The station serial number, date, and time are inserted by the equipment. When received, the acknowledgement of receipt from the receive terminal is recorded.

Receiving a document will be an automatic process, no operator is required. A page will be reproduced, cut to the correct length, deposited in a receive tray. A visual display will be activated to indicate receipt of a message. An acknowledgement of receipt will be automatically sent to the originating terminal and a log kept.

The central switching center will receive the message from the originating terminal, convert it to AUTODIN acceptable format (break it out into packets, add header and trailer information), then send it anywhere in the world at 50,000 kilobits per second speeds. The central switch will handle processing such as data compression, coding, decoding, AUTODIN address of sending and receiving terminals, multiple addresses, validating classification and precedence, and completing local distribution. Low precedence traffic may be held for non-busy hour transmittal. A history file will be maintained to facilitate retransmittal of messages if required.

WHAT ABOUT THE TACTICAL ENVIRONMENT?

There have been other studies completed which recognized FAX as the best medium for transmitting and receiving record communications. Following are the results of two such endeavors.

The TRI-TAC Tactical Digital Facsimile (TDF) (AN/UXC-4( )(V)) is presently in full scale development under a contract awarded to Litton-Datalog. The TDF is a mobile unit which can be used in a vehicle, on a desk, or mounted in a rack. It will be TEMPEST certified and permit automatic message receipt. A low-intensity laser is the light source for both scanning and recording to provide high quality transmission/reception in under 25 seconds at 9600 bits per second with up to 16 shades of gray resolution. (8)

The following quote is from a report, "The Future Tactical Record Traffic Concept," completed by the U. S. Army Signal School. Purpose

of the report was to describe a concept for a new tactical record traffic communication system to support future Army in the field tactical operations:

> System Description Overview: The concept is characterized by the rapid secure transmission of record traffic (narrative and graphic)... Record traffic for combat support and combat service support units is based upon dispersed narrative terminal devices using available single or multichannel communications means. The concept envisions use of simple-to-operate terminal devices, thereby permitting the reduction of highly skilled communication personnel. These devices will be located at or near the user's location, and in most cases can be operated by existing user clerical personnel. In the forward echelons of the division, brigade to battalion, a facsimile device will be used for both narrative and graphic traffic. Facsimile devices will also be used for graphic traffic at echelons above brigade... Signal personnel will be employed in the record traffic system only where absolutely essential to operate message switching devices or to input a large volume of traffic. The use of this concept within the Corps Sector and Theater Army will negate the requirement for HF/RATT and torn tape relay communications." (6:2)

The final recommendations of the Signal School report were that document concepts (including the above) be used as a basis for developing new doctrine and material requirements. Since this concept is in concert with the system proposed by this paper, the same recommendation is adopted here.

CONCLUSIONS

Current record communication systems are not meeting user requirements for convenience, speed of service, and reliability. Actual transmission time is seconds but message preparation and handling can take hours or even days. FAX accepts the source document, no retyping required.

Located in the user's office, FAX eliminates the delays and procedural formalities encountered in dealing with an on-base distribution system and within the TCC.

Maximum speed cannot be achieved until the "middlemen" and manual processes prevalent in teletypewriter and optical character reader operations are eliminated through the use of an automated FAX system. Reduction of specially trained operators and amount of paperwork involved in TTY and OCR transmissions can go far toward justifying any additional expenses FAX may incur.

The concept of combining OCR and FAX will soon be achieved and result in reduction of equipment, while providing maximum flexibility with minimum communications costs. The Government can provide industry with the incentive to develop this concept by including it in planning documents and policy formulation. Since FAX has so many more advantages than TTY or OCR, and combining it with OCR capabilities will make it even more attractive, intensive management review and development should be directed to this area.

Improvements in data compression and coding techniques will make FAX more attractive as a record communications terminal. Standardization of equipment and procedures will provide for a wide community of interest.

Results of the U.S. Army Communications Command FAX Operating Over AUTODIN project should be closely analyzed to determine future direction. The U.S. Air Force Communications Service's OCR/TELEFAX project should be given top-level visibility to insure progress.

SUMMARY

Reduce writer-to-reader time (and do it with less resources)! That is the challenge facing communicators today. The major obstacles to be overcome are message preparation time, in-station handling time, and human error. Facsimile can provide the most direct, error-free communications route. Combined with OCR features and transmitting over AUTODIN, FAX can satisfy all record communications requirements of the future.

Of the three types of transmission media input/output devices (teletypewriter, optical character reader, and facsimile), facsimile has the most desirable characteristics needed to satisfy user requirements. It accepts any type of input, does not require a trained operator, and involves the least number of "middlemen."

FAX enhancements now under development will make FAX operation even more desirable. Getting facsimile to operate over AUTODIN is of major concern today. This will cut communications costs and go a long way toward alleviating the saturation FAX currently causes on AUTOVON. Integrating OCR and FAX capabilities will reduce transmission costs and optimize facsimile utilization. Industry is working in this area and equipment should be available in the 1980's. Improvements in data compression and coding techniques will cut down FAX communications costs.

The ultimate goal is a FAX terminal in the "office of the future," eliminating the need for TTY, OCR, and office copiers. Compact devices will provide the user with a convenient means of transmitting record communications worldwide.

With the implementation of a FAX network, delays and errors such as those encountered in the Pueblo and Liberty incidents will never again be experienced. Reduced writer-to-reader time will insure effective command and control of U. S. Forces worldwide.

BIBLIOGRAPHY

1. Anderson, Howard "Facsimile Data Compression...How It Can Help the Bottom Line," Communications News, Vol. 15, No. 9 (September 1978), 66.

2. Comport, T.L. Facsimile Imagery Technological Forecast, Technical Note 524, San Diego, Naval Ocean Systems Center, 15 September 1978.

3. Coordination Sheet: Source List for Combined OCR/TELEFAX Equipment, DCA, D541, 12 February 1979.

4. "Electronic Mail Technology Ready For Packaging," Data Communications (January 1977), 55.

5. Extracts From Work Study Project: Operation of the High Speed, Digital, Secure Facsimile Over AUTODIN, Headquarters, U.S. Army Communications Command, Fort Huachuca, April 1978 to February 1979.

6. The Future Tactical Record Traffic Concept, Fort Gordon, U.S. Army Signal School, January 1976.

7. Kutnick, Dale "Facsimile Playing Key Role in Office Automation By Electronic Mail," Communications News, Vol. 15, No. 9 (September 1978), 79.

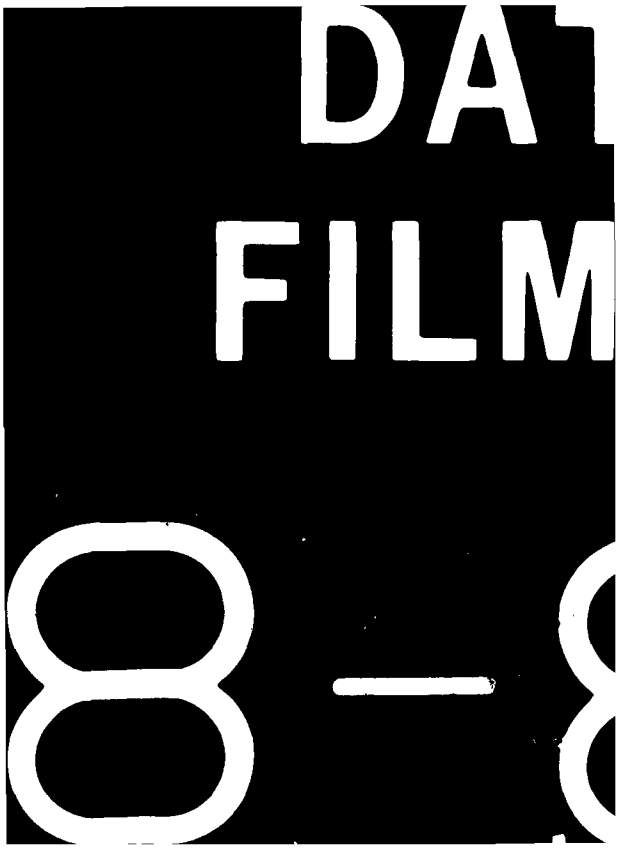
8. Manufacturer's Handout: Tactical Digital Facsimile, AN/UXC-4 ()(V), Washington, D.C., Litton Datalog, 1979.

9. Mission Analysis on Air Force Base Communications--1985, Vol. IIIA, Part 2, L.G. Hanscom Field, U.S. Air Force Systems Command, April 1973.

10. Reins, Edward R., et al. Digital Plotting System for Graphic Information, Patent Application 864,286, Arlington, Office of Naval Research, 20 December 1977.

11. Review of DOD Worldwide Communications, Phase I, Report of the Armed Services Investigating Subcommittee of the Committee on Armed Services, House of Representatives, Washington, D.C., U.S. Government Printing Office, 10 May 1971.

12. Winterbauer, C.E. Facsimile Equipment Survey With Emphasis on Digital Units With Data Compression, Technical Note 447, San Diego, Naval Ocean Systems Center, 24 May 1978.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